Chapter 15
Virtual Environments for Geospatial Applications

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ABSTRACT

This article explores the application of virtual environments to 3D geospatial visualization and exploration. VR worlds provide powerful functionalities for model generation and animation and are indeed a valuable tool for geospatial visualization. Subsequently, related issues such as the constraints in progressive terrain rendering, geographic data modeling, photo-realism in virtual worlds, and the system performance with relatively larger files are discussed. Nevertheless, to accomplish the desired results and to attain a higher level of functionality, a good level of experience in VR programming and the jurisprudence to choose the appropriate tool are necessary. Although a standalone VR application is not capable of a higher level of interaction, using the SCRIPT nodes and the External Authoring Interface additional functionalities can be integrated. Intended for use over the internet with a VR browser, such virtual environments serve not only as a visualization tool, but also a powerful medium for geospatial data exploration.

INTRODUCTION

This chapter explores the application of virtual environments to 3D geospatial visualization, animation, and interaction. The authors describe the design and implementation of some 3D models, which offer a good level of user-interaction and animation. This chapter discusses related issues such as the constraints in progressive terrain rendering, geographic data modeling, photo-realism in virtual worlds, and the system performance with relatively larger files. VR worlds provide powerful functionalities for model generation and animation and are indeed a valuable tool for geospatial visualization. Nevertheless, to accomplish the desired results and to attain a higher

DOI: 10.4018/978-1-4666-2038-4.ch015

level of functionality, a good level of experience in VR programming practices is mandatory. Even though a standalone VR application is not capable of a higher level of interaction, using the SCRIPT nodes, JavaScript can be embedded in the program to provide additional functionalities.

GEO-VIRTUAL ENVIRONMENTS: EVOLUTION OVER THE YEARS

Since the 1960s and 70s, the past several decades have witnessed the 'information revolution', particularly in the domain of spatial information technology, propelled by the advancements in data acquisition techniques. The evolution of diverse digital processing and image generation techniques over the decades along with the parallel developments in Geographical Information Systems GIS and remote sensing have resulted in colossal volumes of digital spatial data. In order to make the utmost use of this collected data, they must be presented in the form of comprehensible information. Geospatial data is increasingly being used for addressing issues involving environmental and urban planning, design, and decision-making within a wide range of disciplines ranging from urban landscape management to various other applications. As geospatial data complexity increases, besides the standard rasters, Triangulated Irregular Networks (TINs) and Digital Elevation Models (DEMs), which are used for data exploration, additional tools such as photo-realistic models are needed to provide advanced visualization and query functionalities. Three-dimensional visualization is a proven technique for exploring geospatial data (Bonham-Carter, 1994). In the work on urban modeling, Shiode (2001) explains the development of 3D models and their role within the domain of spatial information database and remote sensing technology. The origins of concept of spatial immersion can be dated back to 1965 when Ivan Sutherland (1965) made known the ideas of immersion in virtual space in his influential work, "The Ultimate Display". Such immersive virtual environments can serve as handy tools for scientists and researchers that handle enormous data volumes. By and large, visualization enables large quantities of information to be presented in a form that is comprehensible to a wide range of users (Colin Ware, 2000).

3D Geospatial Data Visualization: Tools and Techniques

Geospatial analysis and research require that the data be in the 3D form. Geospatial data is inherently three dimensional in nature since every spatial element has its own position or location in space (latitude, longitude, and altitude). A gamut of applications involving geospatial analysis such as environmental process simulation, infrastructure applications, landscape design, geological applications, etc. necessitates three-dimensional exploration and visualization. Traditionally, operations such as town or country planning relied heavily on drawings and these were eventually supplemented with Computer Aided Design (CAD) drawings. However, one major handicap with these forms of data is that they try to symbolize 3D entities in 2D format. Albeit these may offer a bird's eye view of the place being studied, such representations depicting 3D data using two dimensions are incomplete and cannot replace a 3D view. For instance, landscape and urban modeling architecture applications of today are far more complex and advanced tools are inevitable to provide the required level of sophistication. Several techniques have been tried and implemented for visualizing 3D geospatial data. This paper delineates some of the notable tools and techniques that are employed in 3D geospatial data visualization and briefly elaborates the basic principles underlying the generation of static and dynamic virtual environments.

A plethora of commercial software is available for a wide range of purposes such as terrain or building generation, photogrammetric measure-